

## SECTION 15170

### MOTORS

#### PART 1 GENERAL

##### 1.1 SECTION INCLUDES

- A. Single phase electric motors up to 3/4 horsepower.
- B. 3-phase electric motors up to 200 horsepower.

##### 1.2 SUBMITTALS

- A. Submit the following in accordance with the requirements of Section 01300:
  - 1. Certification that motors meet specified performance and efficiency requirements.
  - 2. Catalog data showing compliance with specified requirements.
  - 3. Wiring diagrams with electrical characteristics and connection requirements.
  - 4. Test reports verifying guaranteed minimum efficiency for 3-phase motors 1 horsepower and larger.
  - 5. Installation instructions including handling, storage, setting, mechanical connections, lubrication, wiring, and testing.
  - 6. Operation and maintenance data:
    - a. Operation data including instructions for safe operating procedures.
    - b. Maintenance data including assembly drawings, bearing data with replacement sizes, and lubrication instructions.
  - 7. Project record documents:
    - a. Report of field tests showing compliance with Part 3 of this specification section.

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**Edit b. to match project requirements; delete if not needed. See instructions for paragraph 3.4 of this Section.**  
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- b. Start-up report from motor manufacturer's service to certify that motor and accessories have been installed, adjusted, and tested in accordance with manufacturer's recommendations.

##### 1.3 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70 - National Electrical Code.
- B. Furnish products listed and labeled by Underwriters Laboratories, Inc., as suitable for purposes specified and shown.

##### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Upon delivery of motors to site, inspect thoroughly for damage.

- B. Store, protect and handle motors following manufacturer's instructions. Provide slings and spreader bars as required. Do not lift motors using shaft as an attachment point.
- C. Install motors as soon as possible. If storage is required, protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. If extended storage is required, follow manufacturer's instructions.

## 1.5 SERVICE CONDITIONS

- A. Provide motors capable of performing satisfactorily in the following service conditions:
  - 1. Altitude of 7500 feet above sea level.
  - 2. Maximum ambient temperature of 104 degrees F, 40 degrees C.
  - 3. Minimum ambient temperature of minus 20 degrees F.
  - 4. 24-hour average temperature not exceeding 86 degrees F.

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**Edit 5 to match project requirements; use only for outdoor equipment.**  
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- [5. Maximum solar heat gain: 110 Watts per square foot.]

## 1.6 WARRANTY

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**This article extends the warranty period beyond one year. Extended warranties add to the construction cost and present difficulties in enforcing them. Specify with caution.**  
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- A. Provide [5] [\_\_\_\_] year warranty under provisions of Section [01700]. [\_\_\_\_\_].
- B. Include extended warranty coverage for motors larger than [20] [\_\_\_\_\_] horsepower.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. General Electric
- B. MagneTec
- C. Baldor

### 2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Motors less than 250 Watts for general applications may be equipment manufacturer's standard product and need not conform to these specifications.
- B. Provide motors with electrical and mechanical performance and characteristics in accordance with NEMA MG-1, Motors and Generators, unless specified otherwise in this Section.

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**Edit C to match project requirements..**  
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C. Electrical Service:

1. 3/4 horsepower and smaller, furnish 115 volts, single phase, 60 Hz motors.
2. Greater than 3/4 horsepower, furnish [200] [230] [460] volts, 3-phase, 60 Hz motors.

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**Edit D to match project requirements..**

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D. Enclosure

1. For clean, dry, indoor locations furnish dripproof type motors.
2. For unfiltered air stream locations in factory assembled equipment furnish either totally enclosed non-ventilated (TENV) or totally enclosed fan-cooled (TEFC) type motors.
3. For [exterior locations] [damp locations] [air cooled condensers] [direct drive axial fans] [roll filters] [dust collection systems] [unfiltered air streams] [\_\_\_\_\_] furnish totally enclosed fan-cooled (TEFC) type motors.
4. For [outdoor locations] [wash down locations] [wet air streams downstream of sprayed coil dehumidifiers] [draw thru cooling towers] [humidifiers] [corrosive] [\_\_\_\_\_] furnish totally enclosed severe duty type motors.
5. For hazardous locations furnish explosion proof motors that are UL labeled for the location hazard classification. Provide explosion proof motors with over temperature protection.
6. Provide 120 volt space heaters in motors as indicated on the Drawings.

E. Rating

1. Furnish motors that are rated on a continuous-duty basis. The output rating shall be available at the shaft at the specified speed, frequency and voltage.
2. Provide motors that have been derated for 7500 feet altitude in accordance with NEMA MG-1. Do not use motor service factor to compensate for altitude. Refer to selection table below.
3. Provide motors designed for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
4. 1 horsepower and larger, furnish Premium Energy-Efficient Type motors.

F. Nameplates:

1. Provide stainless steel nameplates on each motor indicating information required by ANSI/NFPA 70 and section 10.40 of NEMA MG-1.
2. Additional nameplate information may be required by other articles in this Section.
3. Attach nameplates to motor frame with stainless steel fasteners.

G. Wiring Terminations:

1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.

2. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.
  3. Provide a frame grounding screw or lug inside terminal cover or terminal box.
- H. Furnish motors that meet NEMA MG-1-12.49 noise level standards.

## 2.3 SINGLE PHASE POWER - SPLIT PHASE MOTORS

- A. Provide single-phase power, split phase motors for applications less than 1/4 brake horsepower.
- B. Furnish split phase motors that have the following characteristics:
1. Starting Torque: Less than 150 percent of full load torque.
  2. Starting Current: Up to 7 times full load current.
  3. Breakdown Torque: Approximately 200 percent of full load torque.
  4. Insulation: Class A (50 degrees C temperature rise).
  5. Service Factor: Minimum of 1.35 for dripproof motors and 1.0 for enclosed motors.
  6. Bearings: Prelubricated ball bearings.

## 2.4 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

- A. Provide single-phase power, permanent split capacitor motors for shaft mounted fans or blowers 3/4 brake horsepower and smaller.
- B. Permanent split capacitor motors shall have the following characteristics:
1. Starting Torque: Exceeding 1/4 of full load torque.
  2. Starting Current: Up to 6 times full load current.
  3. Multiple Speed: Through tapped windings.
  4. Insulation: Class A (50 degrees C temperature rise).
  5. Service Factor: 1.0
  6. Bearings: Prelubricated ball or sleeve bearings.
  7. Integral Protection: Automatic reset overload protector.

## 2.5 SINGLE PHASE POWER - CAPACITOR START MOTORS

- A. Provide single-phase power, capacitor start motors for applications 1/4 brake horsepower through 3/4 brake horsepower.
- B. Furnish capacitor start motors that have the following characteristics:
1. Starting Torque: 3 times full load torque.
  2. Starting Current: Less than 5 times full load current.
  3. Pull-up Torque: Up to 350 percent of full load torque.

4. Breakdown Torque: Approximately 250 percent of full load torque.
5. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with 2 capacitors in parallel with run capacitor remaining in circuit at operating speeds.
6. Insulation: Class A (50 degrees C temperature rise).
7. Service Factor: Minimum of 1.25 for dripproof motors and 1.0 for enclosed motors.
8. Bearings: Prelubricated ball bearings.

## 2.6 THREE PHASE POWER - SQUIRREL CAGE MOTORS

- A. Provide 3-phase power, squirrel cage motors for applications more than 3/4 brake horsepower
- B. Furnish 3-phase power, squirrel cage motors that have the following characteristics:
  1. Starting Torque: NEMA Design B characteristics.
  2. Starting Current: NEMA designation G, six times full load current.
  3. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
  4. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.
  5. Insulation System: NEMA Class F or better.
  6. Service Factor: 1.15 minimum.
  7. Sound Power Levels: To NEMA MG 1.
- C. Test motors in accordance with NEMA MG-1-12 and IEEE 112, IEEE Standard Test Procedure for Polyphase Induction Motors and Generators. Each motor shall receive a routine commercial test to verify freedom from electrical or mechanical defects. Provide prototype test reports for each rating.
- D. Provide NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
- E. For motor Frame Sizes 254T and larger provide three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter.
- F. Provide grease lubricated anti-friction ball bearings with housings equipped with plugged provision for re-lubrication, rated for minimum ANSI/AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp ANSI/AFBMA bearing identification number on motor nameplate.
- G. For floor-mounted belted applications, provide an adjustable sliding base; for applications above 10 horsepower, sliding base shall have 2 adjusting bolts.
- H. Provide three phase motors having a minimum guaranteed full-load efficiency not less than that tabulated below when tested in accordance with IEEE Std. 112, subclause 6.4, Method B. Motor nameplates shall indicate guaranteed minimum full-load efficiency. Provide motors with nameplate horsepower matched to shaft load as tabulated below; this is to compensate for operating altitude and to include an engineering safety factor.

MINIMUM FULL LOAD EFFICIENCY AND MAXIMUM LOAD							
MOTOR NAME- PLATE HP	NUMBER OF POLES SYNCHRONOUS SPEED, RPM						MAXIMUM SHAFT LOAD (BHP) (DERATED TO 7500 FT ALTITUDE PLUS 10% SAFETY FACTOR )
	OPEN MOTORS			ENCLOSED MOTORS			
	2 3600	4 1800	6 1200	2 3600	4 1800	6 1200	
1	--	82.5	80.0	75.5	82.5	80.0	0.78
1.5	82.5	84.0	84.0	82.5	84.0	85.5	1.17
2	84.0	84.0	85.5	84.0	84.0	86.5	1.56
3	84.0	86.5	86.5	85.5	87.5	87.5	2.35
5	85.5	87.5	87.5	87.5	87.5	87.5	3.91
7.5	87.5	88.5	88.5	88.5	89.5	89.5	5.86
10	88.5	89.5	90.2	89.5	89.5	89.5	7.82
15	89.5	91.0	90.2	90.2	91.0	90.2	11.73
20	90.2	91.0	91.0	90.2	91.0	90.2	15.63
25	91.0	91.7	91.7	91.0	92.4	91.7	19.54
30	91.0	92.4	92.4	91.0	92.4	91.7	23.45
40	91.7	93.0	93.0	91.7	93.0	93.0	31.27
50	92.0	93.0	93.0	92.4	93.0	93.0	39.08
60	92.9	93.6	93.6	93.0	93.6	93.6	46.90
75	93.0	94.1	93.6	93.0	94.1	93.6	58.63
100	93.0	94.1	94.1	93.6	94.5	94.1	78.17
125	93.6	94.5	94.1	94.5	94.5	94.1	97.71
150	93.6	95.0	94.5	94.1	95.0	95.0	117.25
200	94.3	95.0	94.5	94.5	95.0	95.0	156.34

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**Edit I to match project requirements. Coordinate with equipment schedules on the Drawings.**

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- I. Where indicated on Drawings, provide motors suitable for use with part winding starting systems to reduce locked rotor current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.

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**Edit J to match project requirements. Coordinate with equipment schedules on the Drawings.**

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- J. Where indicated on Drawings, provide motors suitable for use in a single winding, variable torque connection for 2 speed fan and centrifugal pump applications.

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**Edit K to match project requirements. Coordinate with equipment schedules on the Drawings.**  
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- K. Where indicated on Drawings, provide motors suitable for use with adjustable frequency controllers as follows:
1. Provide motors that comply with Part 31 of NEMA MG-1 for use with pulse width modulation (PWM) adjustable frequency AC controllers.
  2. Provide motors that comply with Part 30 or 31 of NEMA MG-1 for use with six step adjustable frequency controllers.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Install motors and accessories in accordance with manufacturer's instructions.
- B. Remove any slushing compound on shaft or other parts using a petroleum-type solvent.
- C. Remove shaft shipping braces after motor is placed in its final location.
- D. Install motor securely on firm, level foundation.
- E. Install shaft coupling or sheave in accordance with manufacturers instructions. Do not modify motor shaft to accommodate coupling or sheave.
- F. Align motor axially with driven equipment in accordance with manufacturers' instructions.
- G. Verify that line voltage and phase agree with motor nameplate.
- H. Make electrical connections to motors using materials and methods specified in Sections 16111 and 16120.
- I. Ground motors using materials and methods specified in Section 16450.

### 3.2 FIELD ADJUSTMENTS

- A. Lubricate motor in accordance with manufacturer's instructions.
- B. Turn motor shaft by hand to ensure free rotation.
- C. Verify that the area around motor fan cooling air inlets is free of debris that could be drawn into motor or motor fan during operation.
- D. Check external bolted connections for proper torque.

### 3.3 FIELD TESTS

- A. For motors 1 horsepower and larger, perform insulation resistance test of the stator windings in accordance with ANSI/IEEE Std. 43, IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery, and the motor manufacturer's instructions. Test duration shall be 1 minute. Tabulate resistances at 30 and 60 seconds and calculate the dielectric absorption ratio. Immediately notify Contract Administrator if motor insulation resistance is

less than the following:

1. 460 volt motors: 100 megohms.
2. 230 or 200 volt motors: 25 megohms.

Either replace motor or provide factory-trained manufacturer's service representative to inspect and test motor before making any further tests.

- B. Make an initial uncoupled test of all motors in accordance with manufacturer's installation instructions. Verify proper direction of rotation and monitor bearings for excessive temperature, vibration, or noise. If abnormal noise or vibration is detected, immediately stop test and notify Contract Administrator. Either replace motor or provide a factory-trained manufacturer's service representative to inspect and test motor before making any further tests.
- C. Make coupled start-up tests in accordance with manufacturer's installation instructions and as follows:
  1. Measure and record motor starting time. Verify that it is less than manufacturer's rated stall time.
  2. When motor is at full speed, observe motor for excessive vibration or noise.
  3. Monitor bearing temperatures to verify proper lubrication.
  4. Measure line current in each phase and verify balanced conditions.

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**Edit 3.4 to match project requirements. Balance the benefits and costs of the manufacturer's start-up services against the cost of the motor and the importance of the load it serves. Delete 3.4 if the cost of the manufacturer's start-up service is not warranted.**  
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### 3.4 FIELD QUALITY CONTROL

- A. For motors [100] horsepower and larger, provide services of a factory-trained manufacturer's service representative to assist in installation and start-up of equipment.
- B. Perform the following work under the direction of the manufacturer's service representative:
  1. Verification of proper mounting and alignment.
  2. Final inspection of the lubrication system.
  3. Insulation resistance test.
  4. Final coupled test.
- C. Certify in writing that motor and accessories have been installed, adjusted, and tested in accordance with manufacturer's recommendations.

END OF SECTION